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09/888,989	06/25/2001	Hubert Jerominek	9680.173USU1	9540

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EXAMINER	
RUGGLES, JOHN S	

ART UNIT	PAPER NUMBER
1756	8

DATE MAILED: 07/28/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/888,989	Applicant(s) HUBERT JEROMINEK
	Examiner John Ruggles	Art Unit 1756

-- The MAILING DATE of this communication appears on the cover sh et with th correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 May 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-36* is/are pending in the application.

4a) Of the above claim(s) *19-36* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

Applicant's confirmation in Paper No. 7 of the previous telephone election with traverse of Group I, claims 1-18 in response to the Office action of Paper No. 6 is acknowledged. Accordingly, claims 19-36 remain withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Claim Objections

The previous objection to claim 15 because of a misspelled word has been corrected by applicant's amendment of claim 15 received in Paper No. 7. Accordingly, this objection is now withdrawn.

Claim Rejections - 35 USC § 102

Applicant's arguments filed 19 May 2003 in Paper No. 6 have been fully considered and are found to be partially persuasive. Therefore, the previous 35 U.S.C. 102(b) rejection of claims 1-3, 5-6, 8-10, and 12-13 as being anticipated by Jerominek, et al. (US Patent 5,831,266) of Paper No. 6 is now withdrawn because Jerominek does not specifically require grey scale mask photolithographic patterning to form the sloped support.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 5-6, 8-10, and 12-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jerominek, et al. (US Patent 5,831,266) in view of Goossen, et al. (US Patent 5,443,685), further in view of Laub, et al. (US Patent 5,744,284), further in view of Tuma, et al. (US Patent 5,841,143), and further in view of Dhuler, et al. (US Patent 5,955,817).

Jerominek teaches a method of fabricating a multi-layer microbridge suspended microstructure at column 1, lines 54-55, 60 and at column 6, lines 42-43. The method includes providing a substrate layer (1^{st} layer) with electrical contacts and covering with a temporary layer (2^{nd} layer) of polyimide, glass, SiO2, or Si (instant claims 12-13, for polymer (polyimide) or glass) as shown at column 7, lines 51-60. This is followed by patterning and etching perpendicular or sloped cavities in the temporary layer by a combination of a standard photolithographic process to form a sloped photoresist pattern and a reactive ion etching (RIE) process (reads on subsequent etching through the sloped photoresist pattern to obtain a surface with at least one continuous slope with a predetermined angle with respect to the 1^{st} substrate layer) as taught in column 7, line 61 to column 8, line 5 and shown in Figure 2B (instant claim 1, steps (a)-(c), instant claim 10, for RIE of temporary layer, step (c)). Figure 2B reads on a plateau with two opposite continuous slopes, each having predetermined and substantially equal angles (reads on instant claims 2 and 3). Then, further coating (plasma enhanced chemical vapor deposition, PECVD (instant claim 5), and physical vapor deposition, PVD) and patterning by standard photolithography and dry etching (encompasses ion beam etching, as admitted by instant disclosure page 11, lines 3-4 and RIE is a specie of ion beam etching) or wet etching

(instant claim 10, for dry (RIE) or wet etching of step (e)) of dielectric, metal, and electrically conductive layers (any one of which are comparative to the instant 4th layer, instant claim 1, steps (d)-(e)) is described at column 8, lines 6-44. The dielectric layer is shown to be material selected from the group consisting of Si_3N_4 and SiO_2 (instant claim 8, for Si_3N_4 and SiO_2) at column 7, lines 1-3. In column 8, lines 44-46, the electrically conductive layer is shown to form the legs of the micro support (microstructure). It is also suggested that the order of coating steps could be reversed to form the electrically conductive layer before the dielectric and metal layers at column 8, lines 46-48. Sputtering (instant claim 9, for sputtering) to deposit a radiation active layer of VO_2, V_2O_3, or Si (instant claim 8, for Si) followed by standard photolithographic patterning and etching (RIE) are shown at column 8, lines 49-65. Then, a second electrically conductive layer is deposited by PVD, followed by more dry or wet patterning, disclosed from column 8, line 66 to column 9, line 9. It is further suggested that the order of coating steps could be reversed to form the second electrically conductive layer before the radiation active layer at column 9, lines 9-11. Column 7, lines 34-35 teach that both electrically conductive layers are made of material selected from the group consisting of Au, Ti, W, Al, V (instant claim 8, for Ti, Al, V, and Au). Finally, the remaining temporary layer is removed by isotropic wet (instant claim 6) or dry etching to reveal the suspended microstructure at column 9, lines 27-36 (instant claim 1, step (f)).

While using standard photolithography to create a sloped pattern, Jerominek does not specify using grey scale mask exposure of a photoresist layer to form the sloped pattern (instant claim 1, step (b)). Jerominek does not point out that the suspended microstructure obtained includes a plateau having opposite continuous slopes, each having substantially equal

predetermined angles (instant claims 2-3). Jerominek also does not specifically point out resistive evaporation or electroplating techniques to deposit the 4th layer (instant claim 9, step (d)).

Goossen teaches a process and composition for coating a polar semiconductor onto a non-polar substrate for a variety of integrated electronic and optical applications (column 1, lines 11-15). The process involves photolithographic patterning through a gray scale mask of a resist layer (e.g., polyimide, etc., column 2, line 65) and subsequent developing, resulting in a smooth tapered resist layer 10 as shown in Figure 3 (column 3, lines 4-30 and 45-46). The tapered erodible layer of resist 10 and underlying substrate are then etched (e.g., RIE, plasma ion etching, ion milling, wet chemical etching, etc.) to transfer the smooth tapered resist profile into the substrate (column 4, lines 18-37). The gray scale mask and the relative etching rates of the resist and the substrate predetermine the required angle of taper of the resist and etched substrate (for epitaxial growth of gallium arsenide (GaAs) on silicon (Si) or germanium (Ge), a 3° taper is preferred, column 4, lines 39-62). Tapered substrate surfaces such as these with predetermined angles are useful for a variety of applications, which include those involving subsequent coating (e.g., chemical vapor deposition, etc.) on the tapered substrate (column 5, lines 26-39). One application of this method could be fabrication of a suspended microstructure having a plateau with two opposite continuous sloped tapered supports, each made at a predetermined angle from the substrate, and the angles being either different or substantially equal.

Laub teaches a process of making microbridge (microbeam) structures (microstructures) by forming sloping photoresist patterns (temporary layers) on a substrate, coating over the sloped temporary layers with metal layers, etching the sloped metal layers into desired configurations,

and removal of the temporary layers to form openings between the microbridge and the substrate. Figures 4a-j show progressive stages of this process described at column 5, line 15 to column 6, line 65. Laub specifically points out the advantage of this photolithography technique to create strong and flexible microbridges (microbeams or microstructures) with precise control over their size, shape, and position (encompasses making a plateau having opposite sloped portions positioned at substantially equal predetermined angles) at column 6, lines 52-65.

Tuma teaches fabrication of a sinusoidal, corrugated profile (sloped) multilayer article by selective photoresist exposure, developing, and transfer into underlying dielectric or sensing layer by ion beam milling or dry chemical etching (RIE). The resulting sloped profile is then coated by dielectric (including silicon nitride, Si_3N_4) and metal layers, each deposited by resistive evaporation, electron beam evaporation, ion beam, or RF sputtering shown at column 6, lines 25-64 (instant claim 9, step (d), for resistive evaporation). Tuma states that this method provides thin films suitable (having good coating adhesion) for use in manufacturing small devices (sensors, microstructures).

Dhuler teaches fabrication of an arched beam (suspended microstructure) for a microelectromechanical system (MEMS) actuator by photoresist patterning and subsequent etching of an underlying sacrificial (temporary) plating base, followed by electroplating metal (e.g., Ni, Cu, Au, etc.) on the temporary plating base and removal of remaining photoresist along with temporary portions of the plating base layer to release the arched beam (suspended microstructure) described at column 10, lines 23-54 (instant claim 9, step (d), for electroplating). Dhuler also points out that electroplating is advantageously used for coating the arched beam

(MEMS structure) in a confined space (as found in a multilayer microstructure) at column 6, lines 3-8.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the process steps of Jerominek to obtain a sloped profile with the grey scale mask photolithography shown by Goossen to obtain one or more smooth sloped profiles, each at a predetermined angle and in a single exposure step from a grey scale mask having such a design. It would also have been obvious to combine the process steps of Jerominek and Goossen with the profile and benefits shown by Laub because they relate to the art of manufacturing microstructures.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the subsequent 4th layer coating by resistive evaporation as taught by Tuma, because this method provides good coating adhesion of thin films suitable for use in manufacturing small devices (sensors, microstructures) (instant claim 9, step (d)).

It would also have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the subsequent 4th layer coating by electroplating as shown by Dhuler, because this method also provides good coating adhesion in confined spaces encountered in small device (MEMS arched beam, suspended microstructure) manufacturing (instant claim 9, step (d)).

Claims 4, 7, 11, and 14-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jerominek in view of Goossen, Laub, Tuma, and Dhuler as described above and further in view of Burns, et al. (US Patent 5,559,358).

Jerominek, Goossen, Laub, Tuma, and Dhuler are discussed above, but do not specify deposition of a 5^{th} planarization layer before depositing a 6^{th} layer (instant claim 4, steps (i)-(ii)).

Burns teaches an opto-electromechanical device (microstructure) and a process for making the microstructure by photolithographic patterning, including multiple coating and etching. Several embodiments are disclosed, but particular attention is directed to Figures 3a, 4a, 5a, and 9a-g. Figure 3a shows a microbeam (microbridge) surrounded by cavities formed under a shell (microplatform) having sloped support legs. During operation of this device, the microbeam flexes at a resonance that is sensed by a detector as shown in Figure 4a. Figure 5a shows a similar embodiment in which the resonant member is a microstructure (microplatform) suspended at one end such that the other end can vibrate freely. These devices are made with controlled cavity dimensions and shapes (slope angles). The process to produce such structures is found at column 17, line 35 to column 19, line 62 as related to Figures 9a-g. In order to produce the cavities, sacrificial (temporary) layers were applied with at least the lower temporary layer having a nearly planar (planarized) surface as specified at column 17, line 52 and at column 18, lines 7-10.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the microstructure manufacturing process rendered obvious over Jerominek, Goossen, Laub, Tuma, and Dhuler as explained above by using an additional temporary (5^{th} planarization) layer to allow additional placement of a subsequent (6^{th}) layer at the desired elevation above the substrate as described by Burns (instant claim 4), since Burns shows advantageous manufacture (by similar photolithography, coating, and etching steps) of stacked microstructures having desirable electromechanical properties. It would also have been obvious

to remove this 5th planarization layer along with the remaining temporary layer by the same method of plasma isotropic etching or wet etching (instant claim 7) taught by Jerominek as discussed above, since both layers are sacrificial and temporary. It would have been obvious to deposit the subsequent (6th) layer shown by Burns using plasma enhanced chemical vapor deposition (PECVD) as shown by Jerominek (instant claim 11, step (ii)), because both teachings relate to multilayer microstructure manufacture. In fact, Jerominek even suggests, at column 8, lines 46-48, that the order of coating steps can be reversed so that coating by PECVD could be used to deposit a subsequent (6th) layer.

Further, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the same or similar material (polyimide, glass, SiO_2, or Si as taught by Jerominek at column 7, lines 51-60) for the 5th planarization layer as was used for the 2nd temporary layer (instant claims 14-15, for polymer (polyimide) or glass), since both are sacrificial and temporary, allowing single-step removal by a common solvent or etchant. In microstructure manufacture, Jerominek has shown the benefit and purpose for various coating materials (selected from the group including Si_3N_4, SiO_2, Ti, Al, V, Au, and Si) at column 7, lines 1-3, 34-35 and column 8, line 65 (instant claim 16). As discussed above, Jerominek also suggests that various of these materials can be deposited in a different order (see column 8, lines 46-48 and column 9, lines 9-11), depending on the purpose and function of the microstructure. Therefore, it would have been obvious to select a 6th layer material from this group.

The use of resistive evaporation or electroplating in microstructure fabrication for deposition of the subsequent (6th) layer would be expected to offer the same beneficial results (good coating adhesion in microstructure thin films) as obtained for using them in deposition of

the previous (4^{th}) layer, as discussed above. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify fabrication of a microstructure as taught by Burns to incorporate coating by resistive evaporation as taught by Tuma or electroplating as taught by Dhuler (instant claim 17, step (ii)), in order to obtain good coating adhesion.

Finally, it would also have been obvious to one having ordinary skill in the art at the time the invention was made to modify fabrication of a microstructure as taught by Burns to etch the 6^{th} layer into a microplatform (instant claim 18, step (iii)) by dry etching (encompasses ion beam etching and RIE) or wet etching as described by Jerominek at column 8, lines 6-44 (instant claim 18, step (iii)), because both teachings relate to multilayer microstructure manufacture and are well known in the art (as discussed above).

Response to Arguments

Applicant's arguments filed 19 May 2003 in Paper No. 7 have been fully considered and they are found partially persuasive. Newly amended claims 1, 4, and 15 have been entered.

Applicant's arguments as stated on pages 3-4 in the Remarks section of the amendment of Paper No. 6 filed 19 May 2003, with respect to the previous 35 U.S.C. 102(b) rejection of claims 1-3, 5-6, 8-10, and 12-13 as being anticipated by Jerominek, et al. (US Patent 5,831,266) have been fully considered and are persuasive. Accordingly, this rejection under 102 is now withdrawn because Jerominek does not specifically require grey scale mask photolithographic patterning to form the sloped support. However, it is still maintained that use of a grey scale

mask to form a sloped pattern by photolithography and subsequent etching or coating was not new at the time the invention was made, as discussed above.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., sloped supports which are not part of diagonally opposite inverted pyramids as shown in instant Figures 3 and 6 when compared to Figures 1 and 2B of Jerominek, 5,831,266) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Applicant's other arguments in the Remarks section of the amendment of Paper No. 6 filed 19 May 2003, with respect to the previous 35 U.S.C. 103(a) rejections of claims 1-18 have also been considered but are moot in view of the new ground(s) of rejection. The combination of Goossen with Jerominek leads to a process of fabricating a suspended microstructure with sloped supports. The combined process specifically includes grey scale photolithography to provide one or more smoothly tapered substrates or supports, each at a predetermined angle. It is also pointed out that observation of the Jerominek Figures 1 and 2B at a diagonal cross-section through the center of both inverted pyramid shaped supports suggests fabrication of a plateau with two opposite continuous slopes, each having a predetermined angle in which the predetermined angles are substantially equal. Therefore, the invention as claimed in instant claims 1-3 reads on this combination. The same reasons for combining the remaining teachings of Laub, Tuma, Dhuler, and Burns still apply and are restated, above.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

J. Ruggles

John Ruggles
Examiner
Art Unit 1756

Mark F. Huff

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